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RESEARCH MEMORANDUM

LOW-SPEED INVESTIGATION OF THE
LATERAL-CONTROL CHARACTERISTICS OF A FLAP-TYPE SPOILER
AND A SPOILER-SLOT-DEFLECTOR ON A 30° SWEPTBACK
WING-FUSELAGE MODEL HAVING AN ASPECT RATIO
OF 3, A TAPER RATIO OF 0.5, AND
NACA 65A004 AIRFOIL SECTION

By Alexander D. Hammond

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RESEARCH MEMORANDUM

LOW-SPEED INVESTIGATION OF THE LATERAL-CONTROL CHARACTERISTICS OF A FLAP-TYPE SPOILER AND A SPOILER-SLOT-DEFLECTOR ON A 30° SWEPTBACK WING-FUSELAGE MODEL HAVING AN ASPECT RATIO OF 3, A TAPER RATIO OF 0.5, AND NACA 65A004 AIRFOIL SECTION

By Alexander D. Hammond

SUMMARY

A wind-tunnel investigation has been made at low speed in the Langley 300 MPH 7- by 10-foot tunnel to determine the effect of deflector projection on the control effectiveness of spoiler-slot-deflectors on a 30° sweptback wing-fuselage model equipped with either a 15-percent-chord spoiler or a spoiler-slot-deflector that extended from the 20- to the 99-percent-semispan station of the right wing. The wing had an aspect ratio of 3, a taper ratio of 0.5, and NACA 65A004 airfoil section. The tests were made at angles of attack from -4° to 24° at a Mach number of 0.26 for control projections from 0 to 12 percent chord. The deflector of the spoiler-slot-deflector configuration was tested at projections from zero to a projection equal to the spoiler projection at each spoiler projection.

The results of the investigation indicate that increasing the deflector projection at a given spoiler projection generally increases the rolling-moment effectiveness of the spoiler-slot-deflector configurations except in the angle-of-attack range between -4° and 10° for deflector projections larger than three-quarters of the spoiler projection and except for angles of attack above 20° for deflector projections generally less than 4 percent of the wing chord. Spoiler-slot-deflector configurations with control-projection ratios between 0.5 and 1.0 have considerably improved rolling-moment characteristics over those of the plain spoiler, particularly in the angle-of-attack range above 12° when the plain spoiler exhibits little or no control effectiveness. The spoiler-slot-deflector configuration with an increasing control-projection ratio with increasing control projection appears to have about the optimum rolling-moment effectiveness when the entire angle-of-attack range is considered.

INTRODUCTION

Recent investigations of spoiler-type controls suitable for use on high-speed thin-wing configurations have shown that the spoiler-slot-deflector has certain advantages over the plain flap-type spoiler, such as lower hinge moments and more effectiveness at high angles of attack. (For example, see ref. 1.)

One of the variables to be considered in the design of a spoiler-slot-deflector is the ratio of the projection of the deflector to that of the spoiler. In order to determine the variation of the lateral-control characteristics of a spoiler-slot-deflector with deflector projection at a given spoiler projection, an investigation has been made in the Langley 300 MPH 7- by 10-foot tunnel on a 30° sweptback wing-fuselage model. The right wing of the model was equipped with a 15-percent-wing-chord spoiler, slot, and deflector extending from 0.20b/2 to 0.99b/2, enabling tests to be made on a plain spoiler and a spoiler-slot-deflector configuration at various control projections.

A pressure-distribution investigation performed in the Langley 300 MPH 7- by 10-foot tunnel on this model for which pressure measurements were made at 6 spanwise stations on the wing and at 5 spanwise stations on the spoiler and deflector on the model of this investigation is reported in reference 2.

The discussion of the results of the data of this investigation will be confined to the effect of deflector projection on the rolling effectiveness of the spoiler-slot-deflector.

COEFFICIENTS AND SYMBOLS

The data are presented about the model wind axes with the origin on the fuselage center line at a longitudinal position corresponding to the quarter-chord of the mean aerodynamic chord (fig. 1).

C_L lift coefficient, $\frac{\text{Lift}}{qS}$

C_D drag coefficient, $\frac{\text{Drag}}{qS}$

C_m pitching-moment coefficient about $0.25\bar{c}$, $\frac{\text{Pitching moment}}{qS\bar{c}}$

C_l rolling-moment coefficient, $\frac{\text{Rolling moment}}{qSb}$

$C_{l,s}$ rolling-moment-coefficient increment resulting from control projection

C_n yawing-moment coefficient, $\frac{\text{Yawing moment}}{qSb}$

$C_{n,s}$ yawing-moment-coefficient increment resulting from control projection

b span, ft

c local wing chord, ft

$\bar{c}$ wing mean aerodynamic chord, $\frac{2}{S}\int_0^{b/2} c^2 dy$, ft

a distance from fuselage nose, in.

r fuselage radius, in.

q free-stream dynamic pressure, lb/sq ft

S total wing area, sq ft

y spanwise coordinate measured from plane of symmetry, ft

α angle of attack, deg

δ_s spoiler projection, fraction of wing chord, negative when trailing edge is above wing surface

δ_d deflector projection, fraction of wing chord, negative when leading edge is below wing surface

δ_d/δ_s control projection ratio

MODEL AND APPARATUS

The model used in this investigation consisted of a sweptback wing and fuselage mounted in the Langley 300 MPH 7- by 10-foot tunnel on the single strut which, in turn, was mounted on a six-component balance system

in such a manner that all the forces and moments acting on the model could be measured. The geometric characteristics and dimensions of wing and fuselage are shown in figure 1. The wing was built with a steel core with wood and plastic surfaces and had 30° of sweepback of the quarter-chord line, an aspect ratio of 3, a taper ratio of 0.5, and no twist or dihedral. The wing had NACA 65A004 airfoil sections parallel to the plane of symmetry. The fuselage ordinates are given in figure 1. The wing was mounted 0.125 inch above the center line of the fuselage.

The right wing of the model was equipped with a 15-percent-chord spoiler and deflector extending from $0.20b/2$ to $0.99b/2$. The spoiler and deflector were made of 0.09-inch-thick brass plates that were hinged along the 55-percent- and 70-percent-chord lines, respectively. Over the span of the spoiler and deflector there was a slot through the wing between the 55- and 70-percent-chord lines except for three 0.5-inch-wide stiffener webs whose center lines were at the 40-, 60-, and 80-percent-semispan stations. The webs were undercut 0.09 inch on both upper- and lower-wing surfaces to allow the spoiler and deflector to have a continuous span. (See fig. 1.)

TESTS

All the tests were made in the Langley 300 MPH 7- by 10-foot tunnel at a free-stream dynamic pressure of approximately 100 pounds per square foot which corresponds to a Mach number of 0.26 and a Reynolds number of 2.6×10^{6} based on the wing mean aerodynamic chord of 1.795 feet. The data are presented for a range of spoiler projections from 0 to $-0.12c$ for the plain spoiler and spoiler-slot-deflector configurations. For all plain spoiler tests the deflector was at zero deflection and for the spoiler-slot-deflector configuration the projection of the deflector varied from zero to a projection equal to the spoiler projection. All gaps were sealed for tests for which either the spoiler or the deflector were at zero projection. All tests were made through an angle-of-attack range from -4° to 24°.

CORRECTIONS

Blockage corrections have been applied to the data according to the method of reference 3 to account for the constriction effects of the model on the tunnel free-stream flow. Jet-boundary corrections as determined by the method of reference 4 have been applied to the drag and angle of attack.

RESULTS AND DISCUSSION

The aerodynamic characteristics of the wing-fuselage model, with the various control configurations, are presented in table I. The basic wing longitudinal characteristics are presented in figure 2. The rolling-moment characteristics of the spoiler and spoiler-slot-deflector configurations are presented in figures 3 and 4.

The variation of the rolling-moment coefficient of the control configurations with deflector projection (fig. 3) indicates that increasing the deflector projection generally increases the rolling-moment effectiveness at all spoiler projections investigated. There are, however, two notable exceptions to this trend, one at angles of attack between -4° and 10° for deflector projections larger than three-quarters of the spoiler projection, and the other exception occurs at angles of attack greater than approximately 20° for deflector projection less than 4-percent wing chord.

A study of the pressure-distribution data of reference 2, for one of the spoiler-slot-deflector configurations of these tests, indicates that, in the low angle-of-attack range, the flow over the lower wing surface reattaches behind the deflector at low projections. As the deflector projection is increased for a given spoiler projection there is a decrease in pressure over the lower wing surface (increase in $C_{l,s}$) until just prior to flow separation behind the deflector at which point the maximum rolling moment is obtained. However, the trend of the pressure data seems to indicate that, if the spoiler projection were increased, a higher projection of the deflector would be required to separate the flow over the wing behind the deflector, as a result of the increase in flow through the wing slot resulting from the increased slot size and spoiler height. For example, the results of figure 3 show a maximum rolling effectiveness for a deflector projection of -0.075c at a spoiler projection of -0.10c and for a deflector projection of -0.09c at a spoiler projection of -0.12c.

The variation of the incremental rolling moment with angle of attack for the various control-projection ratios (fig. 4) indicates that the spoiler-slot-deflectors with a control-projection ratio (δ_d/δ_s) between 0.5 and 1.0 show considerably improved rolling-moment characteristics over the plain spoilers $(\delta_d/\delta_s = 0)$, particularly in the angle-of-attack range above 12° where the plain spoilers generally show reversed control effectiveness. For small control deflections $(\delta_s = -0.04c$ or less$)$, the spoiler-slot-deflector configuration with a control-projection ratio of 0.5 shows control effectiveness up to an angle of attack of approximately 23° (fig. 4). However, spoiler-slot-deflector configurations with control-projection ratios greater than 0.5 show reversed control effectiveness at angles of attack above 17° for a spoiler projection of -0.04c.

With this consideration in mind, it appears that, in general, throughout the angle-of-attack range a spoiler-slot-deflector configuration having an increasing projection ratio with increasing control projection has about the optimum rolling-moment effectiveness. Results of another investigation of a similar spoiler-slot-deflector configuration on a 35° sweptback wing have indicated that the hinge-moment characteristics are better for the control with an increasing projection ratio with increasing control projection than for a spoiler-slot-deflector with a constant projection ratio.

The rapid loss in rolling-moment coefficient shown for the spoiler-slot-deflector configurations for angles of attack above 20° (fig. 4) is associated with the large positive rolling-moment-coefficient values shown for the plain wing in table I(a) at these angles of attack since they were subtracted from the total measured rolling-moment coefficients to get the data that are presented. The incremental root-bending-moment coefficients for the spoiler-slot-deflector with a control-projection ratio of 0.75 which were obtained from a spanwise pressure-distribution investigation on this model and which are reported in reference 2 show similar loss in control effectiveness for angles of attack above approximately 20°.

CONCLUSIONS

A wind-tunnel investigation was made at low speed to determine the effect of deflector projection on the control effectiveness of spoiler-slot-deflectors on a 30° sweptback wing-fuselage model. The wing had an aspect ratio of 3, a taper ratio of 0.5, and NACA 65A004 airfoil section. The tests were made at angles of attack from -4° to 24° at a Mach number of 0.26 which corresponds to a Reynolds number of 2.6×10^{6} and for control projections from 0 to 12 percent chord. The deflector of the spoiler-slot-deflector configurations was tested at projections from zero to a projection equal to that of the spoiler at each spoiler projection. The results of the investigation led to the following conclusions:

1. Increasing the deflector projection at a given spoiler projection generally increases the rolling-moment effectiveness of the spoiler-slot-deflector configurations. There are, however, two notable exceptions to this trend, one at angles of attack between -4° and 10° for deflector projections greater than three-quarters of the spoiler projection and the other exception occurs at angles of attack above 20° for deflector projections less than 4-percent wing chord.

2. Spoiler-slot-deflector configurations with control-projection ratios between 0.5 and 1.0 have considerably improved rolling-moment characteristics over the plain spoiler, particularly in the angle-of-attack range above 12° where the plain spoiler generally shows reversed control effectiveness.

3. The spoiler-slot-deflector configuration with an increasing projection ratio with increasing control projection appears to have about the optimum rolling-moment effectiveness when the entire angle-of-attack range is considered.

Langley Aeronautical Laboratory,
National Advisory Committee for Aeronautics,
Langley Field, Va., May 29, 1956.

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TABLE I.- FORCE AND MOMENT COEFFICIENTS

(a) $\delta_s = 0$; $\delta_d = 0$

α, deg	C_L	C_D	C_m	C_l	C_n	C_Y
-4.01	-0.261	0.0329	0.016	0.0012	0.0006	0.0028
-1.91	-.133	.0235	.019	.0013	.0009	.0006
.19	-.015	.0192	.023	.0013	.0006	-.0006
2.29	.107	.0195	.025	.0013	.0009	-.0017
4.40	.249	.0292	.030	.0016	.0011	-.0022
6.53	.399	.0541	.030	.0018	.0011	-.0022
8.64	.534	.0900	.023	.0020	.0006	-.0022
10.64	.659	.1296	.014	.0022	.0010	-.0033
12.73	.763	.1816	.000	.0031	.0010	-.0039
14.87	.812	.2308	-.018	.0038	.0010	-.0044
16.90	.850	.2755	-.033	.0039	.0008	-.0038
18.91	.871	.3161	-.038	.0030	.0017	-.0027
20.93	.890	.3556	-.041	.0034	.0008	-.0011
22.93	.885	.3929	-.046	.0065	.0023	.0000
23.92	.876	.4157	-.049	.0095	.0011	.0016

TABLE I.- FORCE AND MOMENT COEFFICIENTS - Continued

(b) δ_s = -0.005c

δ_d = -0.0025c

α, deg	C_L	C_D	C_m	$C_{l,s}$	$C_{n,s}$	C_Y
-4.01	-0.258	0.0326	0.018	0.0004	-0.0006	0.0028
-1.91	-.130	.0236	.020	.0006	-.0005	.0017
.19	-.013	.0196	.024	.0006	.0000	.0011
2.29	.113	.0206	.027	.0010	-.0005	.0006
4.40	.251	.0324	.033	.0008	-.0005	-.0006
6.53	.403	.0537	.032	.0008	-.0007	-.0011
8.64	.537	.0901	.023	.0010	-.0005	-.0011
10.73	.652	.1313	.015	.0021	-.0009	-.0017
12.82	.756	.1890	.001	.0019	-.0010	-.0028
14.86	.812	.2312	-.019	.0011	-.0010	-.0022
16.89	.845	.2749	-.033	.0010	-.0004	-.0016
18.91	.868	.3148	-.038	.0018	-.0009	-.0005
20.92	.882	.3573	-.043	.0019	-.0019	-.0016
22.91	.869	.3911	-.045	.0076	-.0138	-.0027
23.92	.878	.4151	-.049	.0066	-.0100	.0038

δ_d = -0.005c

α, deg	C_L	C_D	C_m	$C_{l,s}$	$C_{n,s}$	C_Y
-4.01	-0.253	0.0322	0.019	0.0000	-0.0002	0.0028
1.91	-.130	.0233	.020	.0004	-.0003	.0011
.19	.008	.0195	.024	.0009	.0003	.0004
2.29	.109	.0202	.028	.0011	-.0003	.0000
4.40	.249	.0293	.033	.0012	.0000	-.0011
6.53	.404	.0559	.033	.0013	-.0009	-.0011
8.64	.537	.0870	.025	.0014	.0000	-.0006
10.73	.652	.1322	.018	.0021	-.0108	-.0022
12.82	.751	.1851	.003	.0022	-.0008	-.0033
14.87	.812	.2301	-.019	.0011	-.0010	-.0017
16.89	.842	.2760	-.034	.0010	.0000	-.0016
18.91	.866	.3125	-.038	.0019	-.0013	-.0011
20.92	.882	.3559	-.043	.0035	-.0023	.0011
22.92	.882	.3929	-.044	.0088	-.0092	-.0005
23.92	.873	.4138	-.047	.0077	-.0159	.0022

δ_d = -0.0325c

α, deg	C_L	C_D	C_m	$C_{l,s}$	$C_{n,s}$	C_Y
-4.02	-0.252	0.0337	0.018	0.0000	0.0000	0.0028
-1.92	-.133	.0242	.019	.0002	.0000	.0011
.18	-.018	.0195	.023	.0006	.0003	.0006
2.32	.134	.0209	.025	.0004	.0002	.0000
4.44	.268	.0312	.032	.0002	-.0002	-.0017
6.57	.412	.0544	.032	.0006	-.0007	-.0011
8.70	.558	.0894	.024	.0008	-.0002	-.0017
10.80	.670	.1312	.017	.0023	-.0006	-.0022
12.89	.778	.1878	.003	.0016	-.0004	-.0028
14.94	.827	.2299	-.019	.0007	.0000	-.0022
16.97	.860	.2772	-.032	.0006	-.0014	-.0011
17.00	.892	.3167	-.040	.0010	-.0017	-.0005
21.00	.902	.3586	-.042	.0021	.0003	.0000
22.99	.882	.3863	-.044	.0072	-.0108	.0033
24.00	.893	.4080	-.047	.0062	-.0100	.0033

TABLE I.- FORCE AND MOMENT COEFFICIENTS - Continued

(c) $\delta_s = -0.01c$

α, deg	C_L	C_D	C_m	$C_{l,s}$	$C_{n,s}$	C_Y	α, deg	C_L	C_D	C_m	$C_{l,s}$	$C_{n,s}$	C_Y
$\delta_d = 0$							$\delta_d = -0.0075c$						
-4.00	-0.247	0.0366	0.019	-0.0003	-0.0006	0.0011	-4.01	-0.258	0.0336	0.018	0.0009	0.0000	0.0022
-1.90	-.127	.0281	.021	.0000	-.0009	.0006	-1.91	-.129	.0248	.020	.0012	.0002	.0006
.19	-.016	.0253	.025	-.0002	-.0006	.0000	.19	-.018	.0211	.023	.0019	.0009	.0006
2.29	.113	.0255	.028	-.0002	-.0007	-.0006	2.29	.104	.0224	.028	.0023	.0008	.0000
4.40	.246	.0337	.033	.0000	-.0007	-.0011	4.40	.244	.0305	.033	.0021	.0002	-.0017
6.53	.405	.0563	.034	.0005	0011	-.0022	6.52	.394	.0552	.033	.0025	-.0009	-.0017
8.64	.540	.0922	.024	.0002	-.0006	-.0017	8.62	.516	.0883	.025	.0030	-.0004	-.0017
10.73	.649	.1334	.016	.0006	-.0017	-.0028	10.73	.647	.1333	.019	.0042	-.0001	-.0011
12.80	.738	.1851	.000	-.0005	-.0014	-.0022	12.81	.746	.1838	.004	.0020	-.0006	-.0022
14.85	.788	.2220	-.019	-.0003	-.0014	-.0006	14.86	.811	.2306	-.017	.0015	-.0008	-.0017
16.87	.819	.2678	-.032	.0002	-.0014	.0000	16.89	.846	.2758	-.031	.0010	-.0014	-.0005
18.89	.847	.3139	-.038	-.0004	-.0021	.0005	18.91	.865	.3160	-.038	.0018	-.0044	.0005
20.90	.848	.3444	-.043	.0017	-.0018	.0016	20.91	.862	.3422	-.040	.0046	-.0042	.0005
22.89	.845	.3795	-.048	.0046	-.0111	.0044	22.91	.870	.3883	-.042	.0061	-.0084	.0011
23.89	.842	.3910	-.048	.0034	-.0021	.0033	23.92	.880	.4141	-.045	.0028	-.0119	.0043
$\delta_d = -0.005c$							$\delta_d = -0.01c$						
-4.01	-0.256	0.0334	0.018	0.0006	0.0000	0.0023	-4.01	-0.259	0.0350	0.019	0.0009	0.0006	0.0011
-1.91	-.130	.0248	.019	.0010	.0000	.0017	-1.91	-.130	.0257	.019	.0009	.0008	.0000
.18	-.019	.0205	.024	.0015	.0005	.0006	.18	-.022	.0220	.024	.0009	.0011	-.0006
2.29	.109	.0213	.028	.0017	.0004	.0000	2.29	.108	.0227	.027	.0013	.0006	-.0011
4.40	.245	.0315	.032	.0017	-.0002	-.0011	4.40	.244	.0308	.033	.0017	.0004	-.0022
6.53	.403	.0551	.034	.0019	-.0005	-.0017	6.52	.393	.0557	.032	.0025	.0000	-.0022
8.64	.542	.0888	.026	.0025	.0005	-.0011	8.63	.530	.0899	.027	.0023	-.0002	-.0017
10.74	.656	.1357	.017	.0027	-.0004	-.0006	10.73	.645	.1327	.019	.0038	-.0008	-.0028
12.82	.751	.1884	.001	.0022	-.0004	-.0017	12.82	.752	.1825	.004	.0024	-.0008	-.0022
14.86	.806	.2305	-.015	.0020	-.0010	-.0011	14.86	.810	.2310	-.018	.0011	.0000	-.0016
16.89	.840	.2722	-.032	.0012	-.0006	-.0005	16.89	.839	.2738	-.032	.0006	-.0012	-.0011
18.91	.868	.3174	-.038	.0027	-.0009	-.0005	18.90	.860	.3148	-.039	.0017	-.0012	-.0005
20.92	.878	.3587	-.040	.0033	-.0016	.0000	20.92	.873	.3544	-.037	.0035	-.0042	.0000
22.91	.864	.3843	-.042	.0079	-.0129	.0033	22.91	.870	.3899	-.042	.0033	.0017	.0022
23.91	.867	.4109	-.047	.0068	-.0109	.0038	23.92	.877	.4135	-.043	.0029	.0023	.0033

TABLE I.- FORCE AND MOMENT COEFFICIENTS - Continued

(d) $\delta_s = -0.02c$

α, deg	C_L	C_D	C_m	$C_{l,s}$	$C_{n,s}$	C_Y	α, deg	C_L	C_D	C_m	$C_{l,s}$	$C_{n,s}$	C_Y
$\delta_d = 0$							$\delta_d = -0.015c$						
-4.00	-0.246	0.0373	0.015	-0.0019	-0.0005	0.0007	-4.02	-0.272	0.0379	0.017	0.0015	0.0015	0.0017
-1.91	-.135	.0331	.016	-.0015	-.0005	-.0003	-1.92	-.142	.0299	.018	.0021	.0019	.0006
.20	-.006	.0261	.020	-.0010	-.0002	-.0009	.17	-.032	.0254	.023	.0032	.0020	-.0006
2.30	.122	.0268	.025	.0000	-.0003	-.0009	2.28	.093	.0259	.027	.0037	.0019	-.0011
4.41	.256	.0346	.028	-.0008	-.0007	-.0021	4.39	.232	.0348	.033	.0036	.0008	-.0028
6.53	.397	.0578	.030	-.0002	-.0010	-.0028	6.51	.377	.0574	.032	.0036	.0006	-.0017
8.64	.536	.0924	.024	.0003	-.0007	-.0027	8.63	.522	.0919	.026	.0051	.0005	-.0011
10.73	.645	.1336	.016	.0009	-.0011	-.0031	10.72	.629	.1316	.020	.0055	-.0010	-.0022
12.80	.733	.1581	.000	-.0015	-.0011	-.0034	12.80	.732	.1877	.008	.0045	-.0010	-.0011
14.85	.787	.2249	-.022	-.0023	-.0016	-.0030	14.86	.801	.2313	-.015	.0007	-.0002	-.0006
16.87	.821	.2662	-.032	-.0025	-.0012	-.0023	16.88	.835	.2745	-.031	.0007	.0003	.0000
18.89	.837	.3032	-.040	-.0028	-.0066	-.0021	18.90	.849	.3132	-.038	.0022	-.0032	.0011
20.89	.846	.3402	-.043	.0019	-.0061	-.0001	20.91	.871	.3544	-.041	.0030	-.0035	.0027
22.89	.844	.3729	-.045	.0039	-.0103	-.0006	22.92	.882	.3907	-.042	.0005	.0009	.0033
23.90	.848	.3949	-.047	.0026	-.0053	.0019	23.92	.884	.4141	-.045	-.0032	.0029	.0043
$\delta_d = -0.01c$							$\delta_d = -0.02c$						
-4.01	-0.258	0.0360	0.015	0.0009	0.0007	0.0017	-4.02	-0.270	0.0412	0.019	0.0030	0.0022	0.0011
-1.91	-.134	.0280	.016	.0013	.0010	.0006	-1.92	-.148	.0319	.021	.0034	.0021	-.0006
.18	-.022	.0239	.022	.0026	.0013	-.0006	.17	-.036	.0278	.025	.0041	.0024	-.0011
2.28	.094	.0246	.027	.0033	.0012	-.0017	2.27	.086	.0272	.028	.0054	.0021	-.0017
4.40	.239	.0335	.032	.0035	.0006	-.0033	4.39	.228	.0358	.032	.0047	.0010	-.0028
6.52	.391	.0575	.032	.0028	.0000	-.0028	6.51	.378	.0570	.033	.0038	.0010	-.0022
8.63	.522	.0891	.027	.0043	.0000	-.0022	8.62	.516	.0891	.027	.0053	.0007	-.0022
10.73	.643	.1334	.019	.0058	-.0010	-.0028	10.72	.629	.1325	.020	.0064	-.0006	-.0022
12.81	.740	.1767	.004	.0022	-.0002	-.0022	12.80	.734	.1809	.011	.0049	-.0004	-.0017
14.86	.807	.2297	-.015	.0013	-.0008	-.0011	14.85	.799	.2290	-.012	.0032	-.0014	-.0011
16.89	.842	.2743	-.031	-.0001	-.0010	-.0011	16.89	.842	.2740	-.029	.0010	-.0014	-.0005
18.90	.853	.3121	-.037	.0014	-.0030	.0000	18.90	.853	.3113	-.038	.0018	-.0019	.0011
20.92	.873	.3527	-.041	.0031	-.0052	.0005	20.92	.883	.3546	-.040	.0016	-.0039	.0022
22.91	.868	.3855	-.043	.0032	-.0086	.0011	22.93	.889	.3979	-.044	-.0007	-.0018	.0033
23.92	.882	.4128	-.045	.0041	-.0157	.0049	23.92	.880	.4127	-.045	-.0059	-.0022	.0038

TABLE I.- FORCE AND MOMENT COEFFICIENTS - Continued

(e) $\delta_s = -0.04c$

α, deg	C_L	C_D	C_m	$C_{l,s}$	$C_{n,s}$	C_Y
$\delta_d = 0$						
-4.00	-0.247	0.0414	0.013	0.0008	0.0009	0.0006
-1.90	-.125	.0341	.014	.0017	.0008	-.0006
.19	-.011	.0306	.017	.0028	.0011	-.0017
2.29	.108	.0306	.022	.0031	.0010	-.0022
4.40	.247	.0382	.027	.0033	.0004	-.0039
6.53	.399	.0617	.025	.0014	.0004	-.0033
8.64	.534	.0957	.022	.0011	-.0008	-.0028
10.73	.643	.1339	.015	.0006	-.0012	-.0022
12.80	.736	.1832	-.002	-.0016	-.0018	-.0017
14.85	.794	.2243	-.023	-.0028	-.0021	-.0006
16.87	.822	.2671	-.035	-.0030	-.0010	.0006
18.88	.831	.3029	-.041	-.0019	-.0019	.0011
20.89	.836	.3400	-.044	.0022	-.0075	.0038
22.89	.846	.3830	-.048	.0047	-.0039	.0049
23.89	.847	.3900	-.047	.0016	.0144	.0011
$\delta_d = -0.01c$						
-4.02	-0.271	0.0439	0.014	0.0046	0.0028	0.0000
-1.92	-.146	.0344	.017	.0062	.0025	-.0011
.24	-.043	.0296	.023	.0077	.0030	-.0017
2.27	.081	.0293	.028	.0093	.0025	-.0028
4.37	.213	.0383	.033	.0090	.0017	-.0045
6.51	.377	.0607	.028	.0054	.0010	-.0045
8.62	.518	.0924	.022	.0056	.0007	-.0033
10.72	.640	.1361	.017	.0080	-.0008	-.0039
12.80	.738	.1835	.005	.0046	-.0012	-.0022
14.85	.799	.2318	-.018	.0016	-.0019	-.0016
16.89	.840	.2792	-.033	-.0003	-.0025	.0000
18.90	.861	.3079	-.038	.0017	-.0023	.0000
20.91	.866	.3610	-.042	.0030	-.0033	-.0005
22.91	.865	.3872	-.041	.0052	-.0071	.0027
23.92	.879	.4166	-.047	.0047	-.0038	.0027
$\delta_d = -0.02c$						
-4.04	-0.294	0.0474	0.016	0.0065	0.0039	-0.0006
-1.93	-.162	.0378	.017	.0080	.0040	-.0022
.16	-.052	.0330	.022	.0089	.0043	-.0028
2.25	.066	.0320	.026	.0098	.0038	-.0039
4.37	.206	.0392	.031	.0092	.0032	-.0050
6.50	.361	.0602	.031	.0082	.0019	-.0050
8.61	.497	.0928	.024	.0097	.0011	-.0039
10.70	.610	.1258	.021	.0109	.0005	-.0039
12.79	.717	.1805	-.009	.0083	-.0006	-.0022
14.85	.790	.2313	-.014	.0043	-.0012	.0000
16.88	.834	.2703	-.029	.0024	-.0023	.0005
18.90	.853	.3112	-.038	.0014	-.0015	.0016
20.92	.878	.3528	-.039	.0009	.0005	.0022
22.92	.883	.3978	-.042	.0003	-.0043	.0054
23.92	.880	.4173	-.044	-.0049	-.0034	.0038
$\delta_d = -0.03c$						
-4.05	-0.308	0.0542	0.022	0.0100	0.0058	-0.0017
-.195	-.180	.0439	.023	.0103	.0057	-.0033
.14	-.075	.0387	.026	.0110	.0056	-.0039
2.24	.053	.0376	.029	.0121	.0049	-.0050
4.35	.187	.0418	.031	.0125	.0040	-.0067
6.47	.332	.0608	.034	.0118	.0034	-.0045
8.60	.483	.0938	.027	.0109	.0022	-.0033
10.69	.603	.1340	.021	.0110	.0000	-.0039
12.79	.715	.1823	.0011	.0091	-.0016	-.0017
14.84	.782	.2247	-.008	.0054	-.0014	-.0006
16.88	.832	.2697	-.024	.0008	-.0004	.0000
18.92	.873	.3162	-.035	-.0031	.0008	.0016
20.94	.897	.3624	-.041	-.0034	.0041	.0016
22.95	.912	.4011	-.043	-.0074	.0030	.0049
23.94	.899	.4213	-.045	-.0159	.0086	.0054
$\delta_d = -0.04c$						
-4.05	-0.309	0.0591	0.025	0.0100	0.0075	-0.0039
-1.95	-.183	.0478	.027	.0100	.0066	-.0050
.14	-.075	.0417	.029	.0117	.0067	-.0056
2.24	.048	.0407	.032	.0124	.0062	-.0061
4.36	.193	.0441	.035	.0129	.0051	-.0067
6.47	.331	.0628	.037	.0129	.0040	-.0056
8.59	.475	.0961	.030	.0125	.0022	-.0050
10.69	.596	.1345	.024	.0126	.0007	-.0044
12.77	.701	.1813	.016	.0104	-.0002	-.0017
14.82	.763	.2236	-.005	.0079	-.0010	-.0006
16.88	.824	.2715	-.022	.0022	.0000	.0000
18.90	.859	.3185	-.030	-.0020	.0011	.0011
20.95	.913	.3692	-.038	-.0060	.0043	.0022
22.94	.903	.4025	-.041	-.0129	.0040	.0044
23.94	.899	.4188	-.041	-.0191	.0119	.0043

TABLE I.- FORCE AND MOMENT COEFFICIENTS - Continued

(f) $\delta_s = -0.06c$

α, deg	C_L	C_D	C_m	$C_{l,s}$	$C_{n,s}$	C_Y	α, deg	C_L	C_D	C_m	$C_{l,s}$	$C_{n,s}$	C_Y
$\delta_d = 0$							$\delta_d = -0.02c$						
-4.01	-0.267	0.0509	0.008	0.0050	0.0043	-0.0028	-4.06	-0.317	0.0598	0.021	0.0146	0.0075	-0.0056
-1.92	-.152	.0428	.010	.0072	.0038	-.0028	-1.96	-.196	.0492	.024	.0169	.0077	-.0067
.16	-.043	.0385	.017	.0088	.0037	-.0045	.13	-.088	.0446	.028	.0184	.0080	-.0084
2.25	.067	.0380	.022	.0105	.0034	-.0050	2.22	.025	------	-----	.0191	------	-.0095
4.36	.196	.0422	.027	.0112	.0023	-.0072	4.33	.159	.0471	.037	.0203	.0057	-.0106
6.49	.349	.0635	.026	.0078	.0017	-.0067	6.55	.309	.0666	.037	.0184	.0036	-.0083
8.62	.512	.0988	.015	.0021	.0013	-.0039	8.58	.464	.0986	.027	.0145	.0022	-.0061
10.72	.629	.1359	.012	.0029	.0003	-.0028	10.69	.596	.1355	.021	.0146	.0007	-.0061
12.80	.729	.1813	-.004	-.0012	-.0010	-.0006	12.78	.704	.1821	.008	.0106	-.0004	-.0033
14.85	.795	.2239	-.025	-.0045	-.0018	.0006	14.84	.784	.2288	-.014	.0060	-.0014	-.0006
16.88	.825	.2643	-.041	-.0044	-.0027	.0027	16.87	.823	.2711	-.029	.0033	-.0008	-.0005
18.89	.836	.3008	-.043	-.0035	-.0048	.0038	18.89	.843	.3106	-.036	.0033	-.0028	.0011
20.89	.845	.3408	-.044	-.0006	-.0018	.0049	20.91	.864	.3468	-.037	.0025	-.0014	.0011
22.89	.842	.3784	-.046	.0004	-.0104	.0071	22.91	.871	.3928	-.041	.0009	-.0077	.0049
23.90	.852	.3986	-.049	-.0049	-.0040	.0038	23.92	.873	.4092	-.042	-.0022	-.0059	.0038
$\delta_d = -0.01c$							$\delta_d = -0.03c$						
-4.04	-0.296	0.0533	0.014	0.0115	0.0060	-0.0022	-4.08	-0.339	0.0665	0.026	0.0187	0.0099	-0.0067
-2.04	-.293	.0436	.018	.0125	.0057	-.0039	-1.99	-.227	.0556	.031	.0208	.0096	-.0089
.14	-.077	.0397	.023	.0138	.0063	-.0045	.11	-.112	.0501	.034	.0225	.0095	-.0095
2.24	.047	.0384	.028	.0156	.0057	-.0061	2.21	.010	.0477	.037	.0241	.0083	-.0106
4.34	.175	.0411	.035	.0169	.0047	-.0078	4.32	.144	.0492	.041	.0242	.0077	-.0111
6.46	.321	.0934	.031	.0140	.0010	-.0056	6.44	.297	.0686	.040	.0227	.0053	-.0100
10.71	.622	.1354	.017	.0090	.0005	-.0055	8.56	.444	.0982	.030	.0204	.0036	-.0078
12.79	.725	.1828	.003	.0051	-.0010	-.0033	10.67	.578	.1359	.023	.0184	.0007	-.0061
14.85	.797	.2257	-.017	.0011	-.0018	-.0011	12.76	.683	.1822	.010	.0149	-.0006	-.0033
16.89	.836	.2716	-.034	-.0013	-.0014	-.0005	14.83	.772	.2275	-.010	.0107	-.0010	-.0011
18.90	.858	.3121	-.040	.0006	-.0034	.0005	16.87	.819	.2730	-.024	.0061	.0000	-.0005
20.91	.868	.3509	-.042	.0018	-.0037	.0005	18.89	.839	.3102	-.033	.0050	-.0013	.0005
22.92	.878	.3921	-.044	.0020	-.0096	.0027	20.91	.872	.3563	-.036	.0020	.0017	.0022
23.92	.877	.4100	-.047	.0004	.0083	.0005	22.92	.883	.3991	-.039	-.0068	-.0016	.0038
							23.92	.883	.4165	-.040	-.0139	.0104	.0033

TABLE I.- FORCE AND MOMENT COEFFICIENTS - Continued

(f) $\delta_s = -0.06c$ - Concluded

α, deg	C_L	C_D	C_m	$C_{l,s}$	$C_{n,s}$	C_Y
$\delta_d = -0.045c$						
-4.10	-0.363	0.0757	0.034	0.0213	0.0118	-0.0095
-2.00	-.246	.0634	.039	.0247	.0113	-.0100
.09	-.136	.0566	.042	.0271	.0112	-.0106
2.18	-.023	.0534	.047	.0281	.0096	-.0117
4.29	.115	.0541	.049	.0292	.0089	-.0122
6.42	.266	.0716	.048	.0283	.0059	-.0106
8.54	.410	.0963	.041	.0267	.0051	-.0078
10.65	.545	.1348	.031	.0240	.0015	-.0066
12.74	.656	.1804	.019	.0191	-.0010	-.0044
14.81	.748	.2214	.000	.0144	-.0008	.0000
16.86	.800	.2695	-.017	.0092	-.0004	.0000
18.88	.830	.3098	-.027	.0063	-.0008	.0022
20.91	.868	.3569	-.033	.0023	-.0007	.0055
22.92	.884	.4028	-.038	-.0085	.0069	.0043
23.93	.889	.4143	-.038	-.0153	.0102	.0054
$\delta_d = -0.050c$						
-4.10	-0.367	0.0777	0.035	0.0220	0.0120	-0.0094
-2.00	-.245	.0640	.039	.0251	.0111	-.0095
.09	-.137	.0585	.045	.0275	.0114	-.0106
2.18	-.022	.0547	.047	.0282	.0100	-.0122
4.29	.106	.0546	.051	.0292	.0083	-.0134
6.32	.265	.0707	.050	.0285	.0063	-.0106
8.53	.405	.0983	.041	.0268	.0039	-.0078
10.64	.542	.1337	.033	.0244	.0024	-.0055
12.74	.655	.1758	.021	.0197	-.0006	-.0039
14.80	.738	.2244	.001	.0149	-.0018	.0000
16.85	.798	.2704	-.017	.0102	-.0008	.0000
18.88	.831	.3109	-.023	.0079	-.0017	.0016
20.91	.870	.3556	-.030	.0024	.0022	.0033
22.92	.881	.3968	-.036	-.0083	.0080	.0044
23.92	.880	.4152	-.036	-.0146	.0132	.0065
$\delta_d = -0.065c$						
-4.07	-0.333	0.0813	0.038	0.0135	0.0127	-0.0128
-1.97	-.203	.0698	.032	.0134	.0122	-.0133
.11	-.106	.0664	.035	.0172	.0127	-.0145
2.20	.003	.0646	.040	.0203	.0119	-.0150
4.30	.127	.0661	.046	.0233	.0102	-.0156
6.39	.228	.0860	.044	.0219	.0078	-.0133
8.54	.419	.1080	.040	.0222	.0060	-.0100
10.64	.535	.1430	.039	.0251	.0041	-.0089
12.72	.631	.1839	.034	.0240	.0011	-.0066
14.79	.718	.2277	.018	.0211	-.0006	-.0033
16.83	.768	.2710	.001	.0171	-.0010	-.0022
18.86	.806	.3144	-.011	.0133	-.0013	-.0005
20.88	.828	.3553	-.017	.0110	.0013	.0027
22.89	.846	.3912	-.021	.0011	.0044	.0044
23.90	.855	.4186	-.023	-.0082	.0136	.0022

TABLE I.- FORCE AND MOMENT COEFFICIENTS - Continued

(g) δ_s = -0.08c

δ_d = 0

α, deg	C_L	C_D	C_m	$C_{l,s}$	$C_{n,s}$	C_Y
-4.04	-0.293	0.0617	0.011	0.0111	0.0067	-0.0050
-1.95	-.181	.0522	.015	.0130	.0055	-.0061
.14	-.078	.0472	.020	.0156	.0054	-.0072
2.23	.032	.0452	.026	.0169	.0049	-.0078
4.33	.158	.0482	.031	.0183	.0036	-.0095
6.46	.321	.0654	.031	.0152	.0025	-.0089
8.60	.491	.0990	.017	.0075	.0017	-.0067
10.71	.617	.1375	.012	.0050	-.0008	-.0039
12.80	.729	.1802	-.003	-.0007	-.0025	-.0017
14.85	.793	.2203	-.026	-.0052	-.0027	.0017
16.87	.818	.2633	-.043	-.0053	-.0027	.0033
18.89	.840	.3052	-.044	-.0044	-.0057	.0044
20.89	.843	.3406	-.046	-.0028	-.0009	.0055
22.89	.847	.3719	-.048	-.0035	-.0077	.0044
23.90	.850	.4020	-.051	-.0088	.0068	.0011

δ_d = -0.01c

α, deg	C_L	C_D	C_m	$C_{l,s}$	$C_{n,s}$	C_Y
-4.07	-0.333	0.0652	0.019	0.0178	0.0091	-0.007
-1.97	-.208	.0529	.024	.0192	.0077	-.007
.11	-.105	.0480	.029	.0210	.0077	-.009
2.21	.007	.0474	.034	.0236	.0074	-.011
4.31	.133	.0509	.040	.0242	.0058	-.012
6.45	.302	.0673	.038	.0222	.0041	-.008
8.58	.463	.1340	.020	.0158	.0005	-.006
10.69	.602	.1810	.014	.0142	-.0014	-.004
12.79	.722	.2268	.001	.0081	-.0021	.001
16.89	.837	.2693	-.033	-.0008	-.0016	.001
18.90	.857	.3089	-.039	.0008	-.0044	.001
20.91	.865	.3514	-.042	.0024	.0009	.002
22.92	.873	.3869	-.042	.0015	-.0069	.001
23.92	.882	.4067	-.045	.0003	-.0044	.004

δ_d = -0.02c

α, deg	C_L	C_D	C_m	$C_{l,s}$	$C_{n,s}$	C_Y
-4.08	-0.340	0.0703	0.022	0.0196	0.0110	-0.008
-1.98	-.224	.0585	.026	.0212	.0100	-.009
.10	-.116	.0532	.033	.0232	.0099	-.011
2.20	-.002	.0510	.038	.0254	.0089	-.012
4.30	.126	.0530	.042	.0264	.0074	-.013
6.42	.265	.0698	.042	.0255	.0051	-.010
8.56	.443	.0971	.029	.0201	.0034	-.008
10.68	.583	.1385	.020	.0177	.0013	-.007
12.77	.699	.1799	.009	.0107	-.0004	-.003
14.85	.787	.2271	-.013	.0054	-.0016	.000
16.88	.827	.2720	-.030	.0021	-.0035	.001
18.89	.846	.3112	-.036	.0036	-.0032	.001
20.80	.855	.3508	-.037	.0039	-.0048	.001
22.91	.869	.3936	-.039	.0033	-.0094	.003
23.92	.873	.4169	-.041	.0001	-.0075	.005

δ_d = -0.04c

α, deg	C_L	C_D	C_m	$C_{l,s}$	$C_{n,s}$	C_Y
-4.11	-0.381	0.0837	0.032	0.0259	0.0146	-0.0111
-2.01	-.257	.0715	.038	.0292	.0143	-.0122
.08	-.146	.0653	.041	.0312	.0140	-.0139
2.17	-.040	.0622	.046	.0334	.0130	-.0150
4.29	.105	.0624	.047	.0338	.0115	-.0167
6.40	.247	.0792	.047	.0335	.0074	-.0139
8.54	.409	.1068	.035	.0282	.0055	-.0100
10.65	.547	.1391	.032	.0249	.0028	-.0089
12.75	.667	.1832	.011	.0183	.0005	-.0044
14.81	.750	.2298	.000	.0138	-.0012	-.0016
16.86	.803	.2714	-.020	.0097	-.0002	-.0016
18.87	.820	.3107	-.028	.0087	-.0011	.0011
20.91	.866	.3507	-.032	.0052	.0005	.0027
22.92	.880	.3994	-.037	-.0018	-.0033	.0054
23.92	.882	.4197	-.038	-.0073	.0086	.0060

δ_d = -0.065c

α, deg	C_L	C_D	C_m	$C_{l,s}$	$C_{n,s}$	C_Y
-4.12	-0.394	0.1018	0.046	0.0287	0.0178	-0.0183
-2.03	-.283	.0895	.046	.0303	.0175	-.0189
.06	-.174	.0820	.050	.0329	.0172	-.0194
2.14	-.071	.0781	.055	.0372	.0158	-.0200
4.24	.051	.0754	.062	.0406	.0138	-.0211
6.36	.193	.0873	.064	.0409	.0104	-.0178
8.49	.352	.1111	.053	.0378	.0072	-.0144
10.60	.487	.1428	.046	.0337	.0038	-.0122
12.70	.608	.1855	.032	.0298	.0009	-.0072
14.77	.694	.2256	.015	.0247	-.0004	-.0033
16.81	.749	.2711	-.001	.0198	-.0008	-.0005
18.84	.784	.3107	-.011	.0174	-.0021	.0005
20.86	.807	.3516	-.014	.0148	-.0005	.0033
22.88	.832	.3965	-.020	.0084	-.0004	.0054
23.89	.845	.4042	-.023	-.0020	.0106	.0038

δ_d = -0.08c

α, deg	C_L	C_D	C_m	$C_{l,s}$	$C_{n,s}$	C_Y
-4.10	-0.376	0.1024	0.046	0.0211	0.0178	-0.0155
-2.01	-.260	.0895	.046	.0236	.0182	-.0156
.07	-.162	.0840	.053	.0277	.0178	-.0172
2.15	-.059	.0813	.058	.0322	.0166	-.0194
4.25	.060	.0815	.066	.0356	.0153	-.0206
6.36	.201	.0963	.070	.0364	.0119	-.0183
8.49	.349	.1188	.060	.0359	.0085	-.0150
10.59	.481	.1537	.054	.0357	.0060	-.0138
12.68	.591	.1918	.042	.0336	.0034	-.0094
14.75	.673	.2306	.027	.0296	.0009	-.0061
16.80	.727	.2774	.010	.0253	.0004	-.0033
18.82	.762	.3201	.001	.0225	-.0013	-.0016
20.85	.788	.3518	-.002	.0209	-.0035	.0016
22.87	.814	.3933	-.006	.0155	-.0079	.0049
23.87	.819	.4205	-.009	.0061	.0099	.0065

TABLE I.- FORCE AND MOMENT COEFFICIENTS - Continued

(h) $\delta_s = -0.10c$

α, deg	C_L	C_D	C_m	$C_{l,s}$	$C_{n,s}$	C_Y	α, deg	C_L	C_D	C_m	$C_{l,s}$	$C_{n,s}$	C_Y
$\delta_d = 0$							$\delta_d = -0.02c$						
-4.06	-0.318	0.0723	0.014	0.0180	0.0095	-0.0078	-4.10	-0.366	0.0822	0.025	0.0259	0.0135	-0.0106
-1.97	-.203	.0622	.018	.0193	.0081	-.0083	-2.00	-.245	.0695	.030	.0269	.0124	-.0117
.11	-.111	.0568	.023	.0215	.0080	-.0095	.05	-.178	.0656	.034	.0290	.0125	-.0122
2.20	.000	.0539	.030	.0232	.0070	-.0106	2.17	-.040	.0609	.040	.0312	.0117	-.0134
4.30	.125	.0557	.034	.0241	.0059	-.0117	4.27	.088	.0615	.045	.0320	.0091	-.0150
6.43	.277	.0715	.035	.0219	.0029	-.0111	6.40	.242	.0753	.045	.0311	.0057	-.0117
8.58	.463	.1007	.021	.0156	.0028	-.0089	8.55	.422	.1012	.030	.0229	.0034	-.0089
10.69	.601	.1359	.011	.0064	-.0004	-.0055	10.66	.560	.1383	.021	.0183	.0011	-.0077
12.80	.731	.1818	-.002	.0001	-.0038	-.0077	12.77	.693	.1825	.009	.0116	-.0010	-.0033
14.85	.795	.2208	-.025	-.0065	-.0031	.0011	14.84	.786	.2289	-.014	.0055	-.0023	.0000
16.87	.820	.2591	-.039	-.0058	-.0069	.0044	16.88	.826	.2694	-.029	.0009	-.0016	.0016
18.89	.842	.3013	-.042	-.0045	-.0046	.0055	18.90	.849	.3050	-.035	.0036	-.0046	.0016
20.89	.843	.3375	-.045	-.0033	-.0100	.0066	20.90	.860	.3506	-.039	.0043	-.0026	.0033
22.90	.854	.3782	-.048	-.0051	.0030	.0038	22.91	.866	.3868	-.041	.0032	-.0087	.0049
23.90	.860	.4030	-.050	-.0101	.0004	.0054	23.92	.878	.4120	-.043	-.0020	.0000	.0033
$\delta_d = -0.01c$							$\delta_d = -0.04c$						
-4.08	-0.347	0.0761	0.020	0.0229	0.0123	-0.0106	-4.12	-0.393	0.0944	0.033	0.0302	0.0173	-0.0150
-2.00	-.238	.0630	.026	.0243	.0111	-.0106	-2.04	-.287	.0836	.039	.0347	.0157	-.0156
.10	-.128	.0581	.032	.0264	.0110	-.0106	.05	-.184	.0757	.047	.0375	.0161	-.0161
2.18	-.021	.0560	.037	.0282	.0104	-.0128	2.14	-.079	.0713	.052	.0392	.0147	-.0167
4.29	.104	.0576	.042	.0294	.0085	-.0145	4.24	.051	.0697	.055	.0407	.0126	-.0178
6.42	.265	.0718	.043	.0285	.0053	-.0111	6.36	.193	.0797	.056	.0401	.0085	-.0150
8.56	.434	.0998	.027	.0214	.0034	-.0089	8.51	.376	.1030	.042	.0334	.0053	-.0122
10.68	.588	.1375	.019	.0161	.0009	-.0072	10.64	.536	.1389	.030	.0257	.0026	-.0083
12.79	.721	.1847	.005	.0091	-.0014	-.0039	12.75	.667	.1830	.016	.0178	-.0006	-.0039
14.84	.789	.2274	-.015	.0032	-.0027	.0006	14.82	.759	.2269	-.007	.0113	-.0016	-.0006
16.89	.836	.2653	-.031	.0003	-.0029	.0016	16.86	.805	.2715	-.019	.0064	-.0025	.0005
18.90	.849	.3066	-.038	.0028	-.0055	.0026	18.89	.841	.3142	-.026	.0058	-.0002	.0005
20.91	.862	.3526	-.040	.0041	-.0056	.0027	20.90	.850	.3488	-.030	.0054	.0003	.0022
22.92	.874	.3858	-.041	.0035	-.0083	.0044	22.92	.877	.4028	-.034	.0020	.0036	.0027
23.93	.875	.4101	-.043	-.0018	-.0052	.0049	23.92	.884	.4250	-.035	.0083	.0083	.0043

TABLE I.- FORCE AND MOMENT COEFFICIENTS - Continued

(h) δ_s = -0.10c - Concluded

α, deg	C_L	C_D	C_m	$C_{l,s}$	$C_{n,s}$	C_Y
δ_d = -0.05c						
-4.13	-0.406	0.1033	0.038	0.0330	0.0195	-0.0177
-2.05	-.305	.0902	.047	.0386	.0184	-.0178
.03	-.207	.0825	.054	.0412	.0180	-.0189
2.12	-.097	.0778	.059	.0438	.0164	-.0189
4.22	.029	.0747	.062	.0450	.0134	-.0200
6.35	.177	.0842	.062	.0443	.0100	-.0167
8.49	.348	.1058	.050	.0389	.0059	-.0133
10.63	.519	.1390	.037	.0307	.0021	-.0111
12.73	.646	.1820	.023	.0242	-.0006	-.0050
14.80	.737	.2279	.001	.0170	-.0010	-.0022
16.85	.789	.2710	-.013	.0132	0	-.0011
18.86	.811	.3152	-.022	.0118	-.0009	-.0011
20.88	.828	.3556	-.025	.0113	.0024	.0005
22.90	.848	.3998	-.030	.0025	.0046	.0016
23.92	.874	.4151	-.032	-.0070	.0111	.0033
δ_d = -0.075c						
-4.17	-0.451	0.1241	0.058	0.0368	0.0235	-0.0227
-2.06	-.317	.1087	.058	.0371	.0226	-.0227
.02	-.222	.1069	.061	.0414	.0235	-.0244
2.10	-.126	.1021	.069	.0461	.0219	-.0261
4.19	-.008	.0982	.074	.0491	.0192	-.0272
6.30	.126	.1060	.075	.0502	.0152	-.0244
8.44	.293	.1255	.065	.0465	.0115	-.0199
10.56	.441	.1532	.054	.0422	.0014	-.0166
12.68	.584	.1910	.038	.0343	.0036	-.0105
14.74	.664	.2365	.024	.0300	.0007	-.0072
16.79	.717	.2770	.008	.0291	-.0002	-.0033
18.81	.742	.3140	-.001	.0258	-.0032	-.0022
20.83	.770	.3561	-.005	.0230	-.0020	.0022
22.85	.795	.3979	-.010	.0166	-.0036	.0033
23.87	.820	.4153	-.010	.0080	-.0048	.0043

α, deg	C_L	C_D	C_m	$C_{l,s}$	$C_{n,s}$	C_Y
δ_d = -0.09c						
-4.14	-0.417	0.1274	0.054	0.0291	0.0242	-0.0233
-2.04	-.295	.1149	.056	.0312	.0247	-.0238
.04	-.199	.1085	.064	.0344	.0291	-.0244
2.12	-.101	.1030	.072	.0403	.0225	-.0250
4.21	.012	.1011	.080	.0448	.0195	-.0261
6.32	.141	.1105	.079	.0449	.0157	-.0227
8.44	.298	.1308	.072	.0446	.0123	-.0205
10.56	.435	.1609	.067	.0428	.0087	-.0166
12.66	.560	.1960	.055	.0398	.0051	-.0121
14.72	.636	.2362	.043	.0365	.0028	-.0072
16.76	.680	.2778	.028	.0346	.0011	-.0055
18.78	.709	.3168	.017	.0332	-.0015	-.0038
20.80	.732	.3572	.012	.0322	-.0029	-.0022
22.83	.768	.3944	.009	.0268	-.0021	-.0011
23.83	.774	.4147	.005	.0205	-.0017	.0016
δ_d = -0.10c						
-4.13	-0.403	0.1286	0.050	0.0259	0.0235	-0.0205
-2.03	-.279	.1167	.053	.0284	.0241	-.0227
.05	-.186	.1117	.058	.0342	.0244	-.0233
2.13	-.089	.1063	.069	.0389	.0230	-.0244
4.22	.020	.1040	.076	.0429	.0208	-.0255
6.32	.152	.1120	.078	.0439	.0170	-.0222
8.46	.319	.1326	.071	.0427	.0136	-.0199
10.56	.443	.1622	.063	.0419	.0089	-.0171
12.66	.557	.1986	.053	.0395	.0051	-.0121
14.71	.624	.2349	.046	.0381	.0028	-.0066
16.75	.673	.2815	.033	.0363	.0011	-.0038
18.77	.698	.3159	.027	.0356	-.0007	-.0022
20.80	------	------	-----	.0343	------	-------
22.82	.751	.3929	.018	.0302	-.0008	.0027
23.83	.765	.4152	.014	.0227	.0027	.0049

TABLE I.- FORCE AND MOMENT COEFFICIENTS - Continued

(i) $\delta_s = -0.12c$

α, deg	C_L	C_D	C_m	$C_{l,s}$	$C_{n,s}$	C_Y
$\delta_d = 0$						
-4.08	-0.336	0.0849	0.015	0.0207	0.0131	-0.0117
-1.98	-.225	.0731	.020	.0232	.0117	-.0117
.09	-.132	.0679	.025	.0260	.0110	-.0122
2.18	-.022	.0649	.030	.0282	.0098	-.0139
4.28	.101	.0661	.035	.0298	.0083	-.0150
6.40	.245	.0778	.038	.0289	.0059	-.0144
8.55	.430	.1056	.025	.0214	.0034	-.0105
10.68	.581	.1410	.012	.0101	-.0002	-.0072
12.29	.720	.1818	0	.0016	-.0025	-.0022
14.85	.798	.2187	-.022	-.0070	-.0035	.0028
16.87	.822	.2846	-.038	-.0061	-.0044	.0055
18.88	.835	.2975	-.043	-.0047	-.0055	.0055
20.90	.860	.3387	-.044	-.0040	-.0053	.0076
22.90	.858	.3722	-.046	-.0078	-.0055	.0104
23.90	.858	.3856	-.048	-.0140	.0090	.0038
$\delta_d = -0.01c$						
-4.10	-0.362	0.0901	0.021	0.0255	0.0155	-0.0139
-2.01	-.252	.0755	.026	.0282	.0137	-.0139
.08	-.150	.0699	.032	.0304	.0135	-.0145
2.16	-.046	.0684	.037	.0336	.0130	-.0167
4.27	.083	.0690	.041	.0345	.0115	-.0178
6.39	.231	.0812	.042	.0339	.0076	-.0150
8.53	.405	.1045	.031	.0272	.0051	-.0122
10.67	.576	.1407	.017	.0200	.0013	-.0094
12.78	.713	.1830	.005	.0106	-.0014	-.0044
14.86	.807	.2278	-.014	.0025	-.0031	.0006
16.89	.841	.2652	-.032	-.0010	-.0037	.0027
18.89	.846	.3010	-.036	.0028	-.0076	.0038
20.90	.857	.3402	-.038	.0034	-.0079	.0044
22.92	.880	.3877	-.040	.0024	-.0036	.0033
23.92	.880	.4032	-.041	-.0018	-.0076	.0071
$\delta_d = -0.02c$						
-4.11	-0.378	0.0943	0.025	0.0281	0.0172	-0.0155
-2.02	-.268	.0819	.030	.0314	.0162	-.0144
.07	-.163	.0746	.036	.0334	.0161	-.0150
2.15	-.062	.0724	.042	.0354	.0149	-.0178
4.26	.069	.0720	.046	.0364	.0126	-.0183
6.38	.216	.0817	.046	.0369	.0085	-.0156
8.52	.394	.1057	.034	.0286	.0058	-.0116
10.66	.560	.1432	.023	.0209	.0019	-.0100
12.78	.703	.1860	.010	.0119	-.0010	-.0044
14.85	.797	.2273	.011	.0040	-.0014	.0011
16.89	.841	.2699	-.025	-.0002	-.0021	.0011
18.89	.844	.3049	-.033	.0041	-.0053	.0022
20.90	.854	.3469	-.039	.0052	-.0041	.0016
22.92	.880	.3986	-.041	.0022	-.0084	.0044
23.00	------	------	-----	-.0020	-.0025	.0038
$\delta_d = -0.04c$						
-4.14	-0.418	0.1180	0.033	0.0333	0.0208	-0.0205
-2.05	-.309	.0943	.044	.0386	.0196	-.0200
.03	-.209	.0871	.049	.0417	.0191	-.0211
2.12	-.096	.0826	.053	.0434	.0177	-.0222
4.23	.032	.0796	.056	.0434	.0149	-.0233
6.34	.171	.0880	.055	.0435	.0102	-.0200
8.49	.352	.1101	.043	.0378	.0068	-.0166
10.63	.525	.1398	.032	.0303	.0030	-.0122
12.75	.666	.1836	.017	.0187	-.0002	-.0055
14.82	.762	.2270	-.004	.0100	-.0029	-.0011
16.88	.826	.2727	-.021	.0028	-.0008	.0005
18.90	.856	.3135	-.028	.0007	.0015	.0022
20.91	.868	.3648	-.033	.0014	.0044	.0011
22.92	.877	.3948	-.033	.0003	.0005	.0044
23.92	.874	.4214	-.032	-.0070	.0104	.0033
$\delta_d = -0.065c$						
4.18	-0.461	0.1304	0.055	0.0403	0.0254	-0.0266
-2.09	-.351	.1194	.061	.0447	.0260	-.0271
0	-.248	.1121	.065	.0468	.0252	-.0283
2.08	-.150	.1058	.071	.0503	.0236	-.0288
4.18	-.029	.1016	.075	.0549	.0211	-.0300
6.29	.113	.1076	.076	.0541	.0156	-.0272
8.44	.293	.1235	.066	.0489	.0119	-.0222
10.57	.456	.1537	.050	.0405	.0070	-.0171
12.70	.607	.1888	.035	.0303	.0025	-.0099
14.77	.696	.2263	.016	.0241	0	-.0050
16.82	.759	.2699	.001	.0194	.0009	-.0022
18.83	.772	.3104	-.010	.0202	-.0017	-.0005
20.85	.791	.3503	-.012	.0188	-.0012	.0011
22.87	.820	.4001	-.017	.0125	.0048	.0016
23.88	.826	.4149	-.019	.0062	.0004	.0027

TABLE I.- FORCE AND MOMENT COEFFICIENTS - Concluded

(i) δ_s = -0.12c - Concluded

α, deg	C_L	C_D	C_m	$C_{l,s}$	$C_{n,s}$	C_Y	α, deg	C_L	C_D	C_m	$C_{l,s}$	$C_{n,s}$	C_Y
δ_d = -0.08c							δ_d = -0.10c						
-4.19	-0.470	0.1407	0.067	0.0414	0.0280	-0.028	-4.15	-0.430	0.1465	0.062	0.0339	0.0293	-0.0282
-2.09	-.349	.1260	.068	.0423	.0279	-.028	-2.06	-.314	.1343	.061	.0358	.0293	-.0282
.00	-.239	.1176	.069	.0438	.0269	-.028	.02	-.219	.1278	.069	.0413	.0292	-.0288
2.08	-.146	.1136	.079	.0499	.0251	-.030	2.10	-.124	.1248	.080	.0467	.0276	-.0310
4.17	-.040	.1113	.083	.0539	.0231	-.032	4.18	-.024	.1212	.086	.0500	.0255	-.0316
6.28	.092	.1195	.085	.0557	.0186	-.029	6.30	.125	.1258	.087	.0514	.0208	-.0283
8.42	.269	.1347	.072	.0522	.0142	-.025	8.44	.293	.1432	.075	.0485	.0159	-.0238
10.55	.433	.1619	.057	.0450	.0093	-.020	10.56	.434	.1712	.067	.0438	.0112	-.0204
12.67	.571	.1949	.045	.0358	.0036	-.012	12.65	.555	.2015	.058	.0395	.0065	-.0132
14.75	.666	.2349	.028	.0312	.0019	-.007	14.70	.612	.2414	.049	.0395	.0032	-.0088
16.78	.706	.2770	.014	.0296	.0019	-.004	16.74	.664	.2813	.037	.0387	.0021	-.0077
18.80	.730	.3155	.004	.0300	-.0005	-.004	18.75	.673	.3182	.029	.0425	-.0024	-.0049
20.82	.757	.3577	.002	.0298	-.0029	-.001	20.78	.704	.3532	.029	.0410	-.0023	-.0033
22.85	.787	.3954	-.002	.0219	.0015	.002	22.80	.726	.3982	.024	.0345	-.0004	-.0011
23.85	.798	.4160	-.004	.0146	.0050	.003	23.81	.745	.4175	.017	.0262	-.0036	0
δ_d = -0.09c							δ_d = -0.12c						
-4.17	-0.449	0.1454	0.064	0.0382	0.0293	-0.0299	-4.11	-0.384	0.1499	0.043	0.0247	0.0286	-0.027
-2.07	-.328	.1315	.067	.0383	.0287	-.0293	-2.02	-.269	.1411	.048	.0279	.0298	-.028
.02	-.225	.1256	.069	.0429	.0286	-.0299	.05	-.178	.1372	.058	.0343	.0301	-.028
2.09	-.131	.1204	.078	.0476	.0272	-.0310	2.12	-.093	.1336	.068	.0401	.0289	-.030
4.19	-.018	.1161	.084	.0512	.0242	-.0321	4.22	.019	.1317	.077	.0447	.0263	-.031
6.21	.007	.1206	.085	.0534	.0197	-.0283	6.33	.164	.1365	.080	.0459	.0222	-.029
8.43	.283	.1407	.076	.0513	.0148	-.0244	8.47	.328	.1642	.064	.0414	.0185	-.025
10.55	.428	.1664	.066	.0465	.0104	-.0199	10.59	.470	.1840	.057	.0368	.0125	-.020
12.65	.550	.1966	.056	.0395	.0059	-.0127	12.68	.580	.2165	.052	.0344	.0089	-.015
14.72	.629	.2392	.044	.0389	.0025	-.0082	14.72	.635	.2553	.046	.0351	.0065	-.010
16.76	.682	.2805	.028	.0365	.0015	-.0055	16.74	.660	.2470	.037	.0375	.0042	-.009
18.77	.697	.3209	.018	.0375	-.0017	-.0044	18.75	.677	.3325	.034	.0402	.0012	-.007
20.79	.725	.3600	.015	.0365	-.0019	-.0033	20.77	.698	.3672	.035	.0415	.0002	-.004
22.83	.763	.3999	.011	.0302	-.0027	-.0016	22.78	.704	.4009	.040	.0390	-.0002	.001
23.83	.772	.4231	.008	.0260	-.0027	-.0011	23.78	.709	.4312	.038	.0354	-.0036	-.002

Fuselage ordinates, in.			
a	r	a	r
0.000	0.000	23.673	3.897
1.173	.335	26.173	4.047
3.673	.473	28.673	4.138
6.173	1.124	29.173	4.168
8.673	1.709	68.763	4.168
11.173	2.230	71.680	4.062
13.673	2.678	74.596	3.902
16.173	3.082	79.597	3.562
18.673	3.415	91.268	2.750
21.173	3.687		

Wing data:
- Sweep of quarter-chord line, deg . . 30
- Aspect ratio 3.0
- Taper ratio 0.5
- Wing area, sq ft 9.0
- Airfoil section (parallel to plane of symmetry) . . . . NACA 65A004

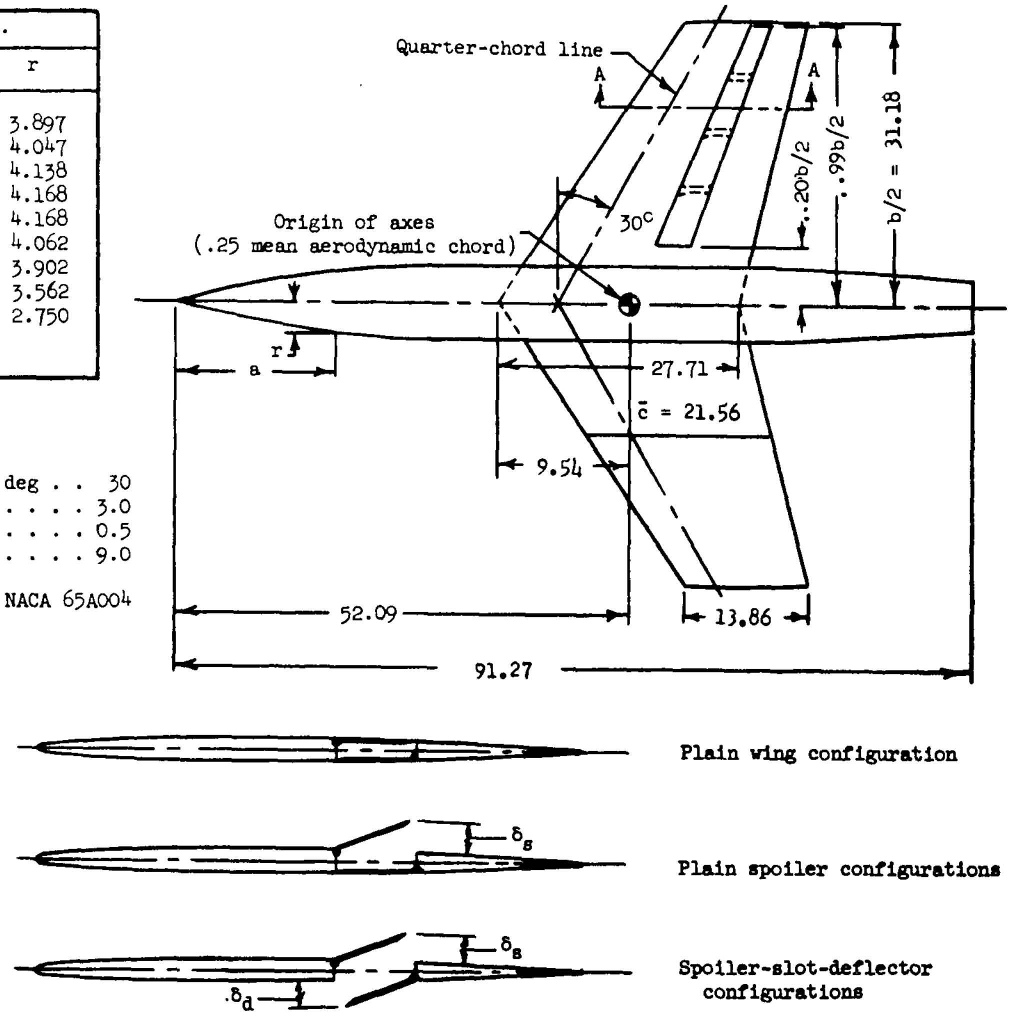

Figure 1.- Geometric characteristics of 30° sweptback wing-fuselage model equipped with spoiler and spoiler-slot-deflector. (All dimensions are in inches unless otherwise noted.)

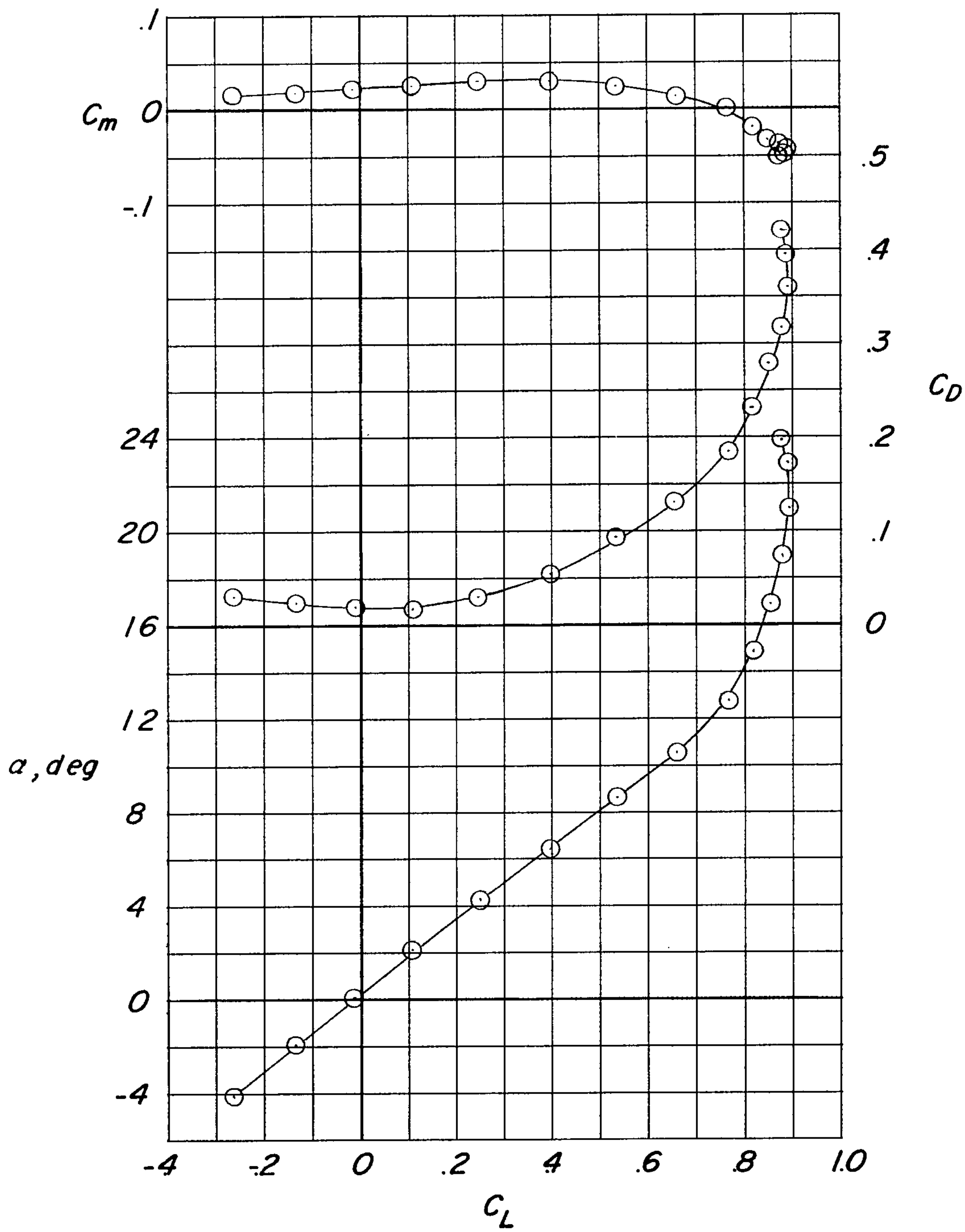

Figure 2.- Aerodynamic characteristics of the 30° sweptback wing-fuselage models with controls neutral.

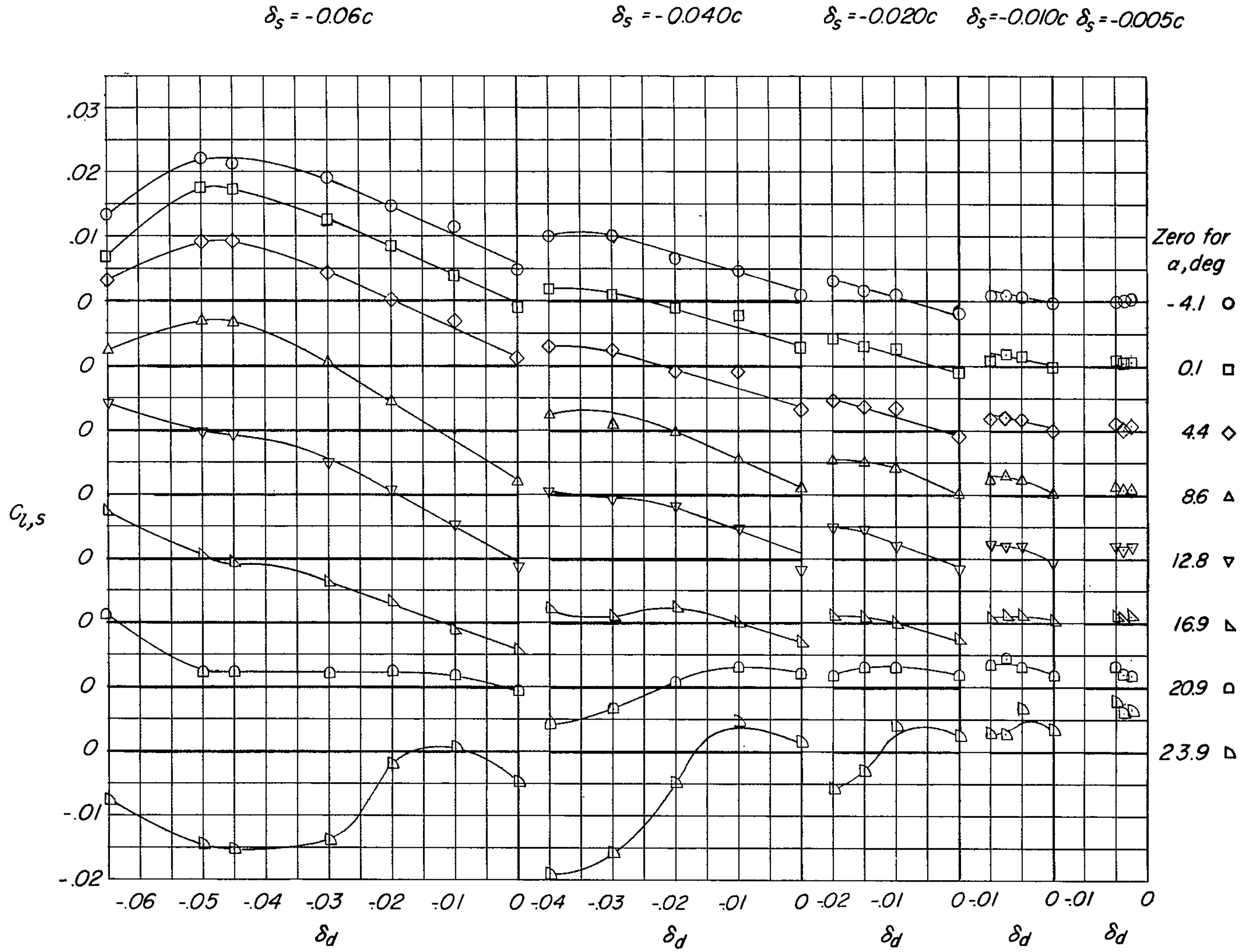

Figure 3.- Variation of rolling-moment coefficient with deflector projection at various angles of attack at spoiler projections from 0 to -0.12c.

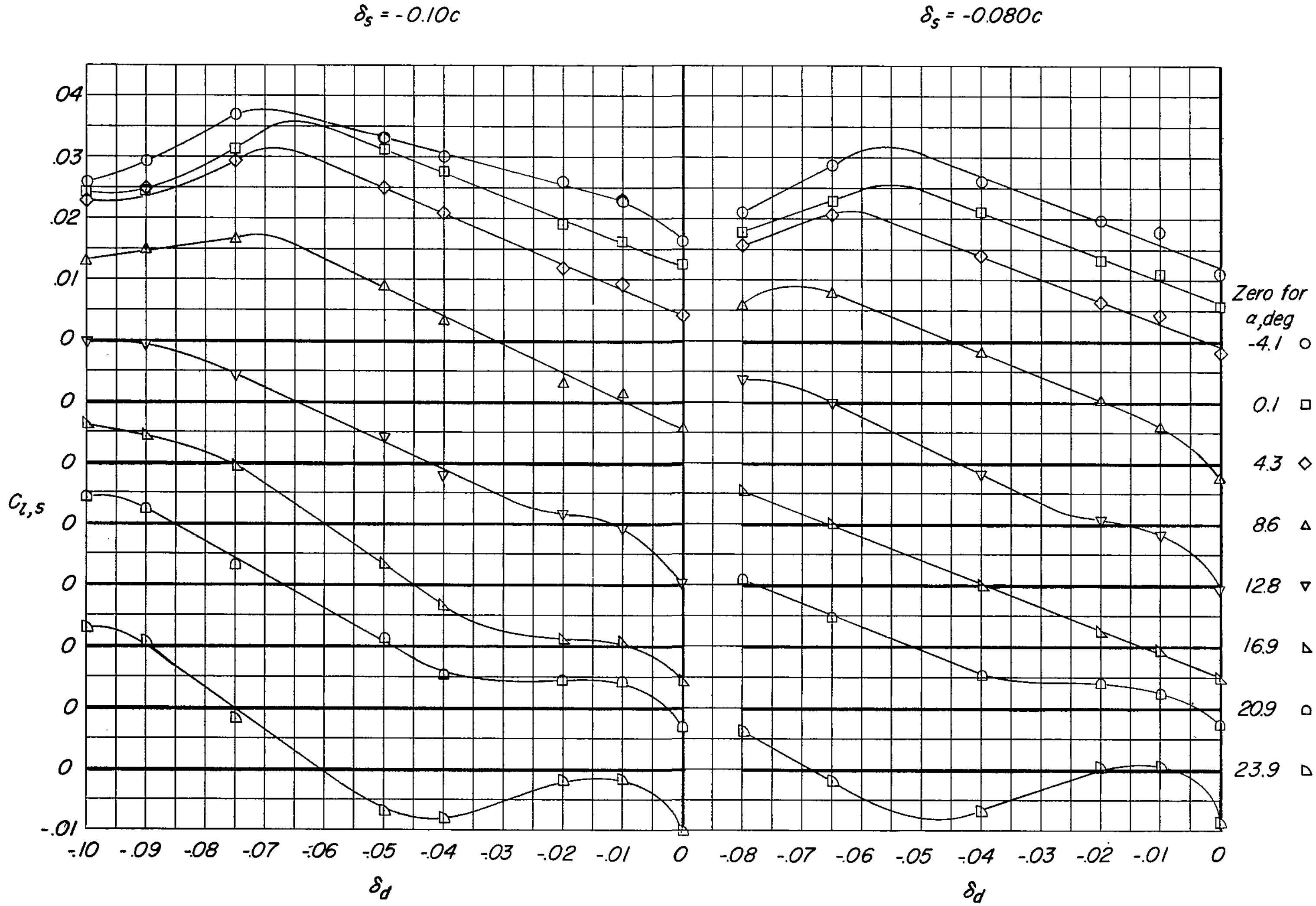

Figure 3.- Continued.

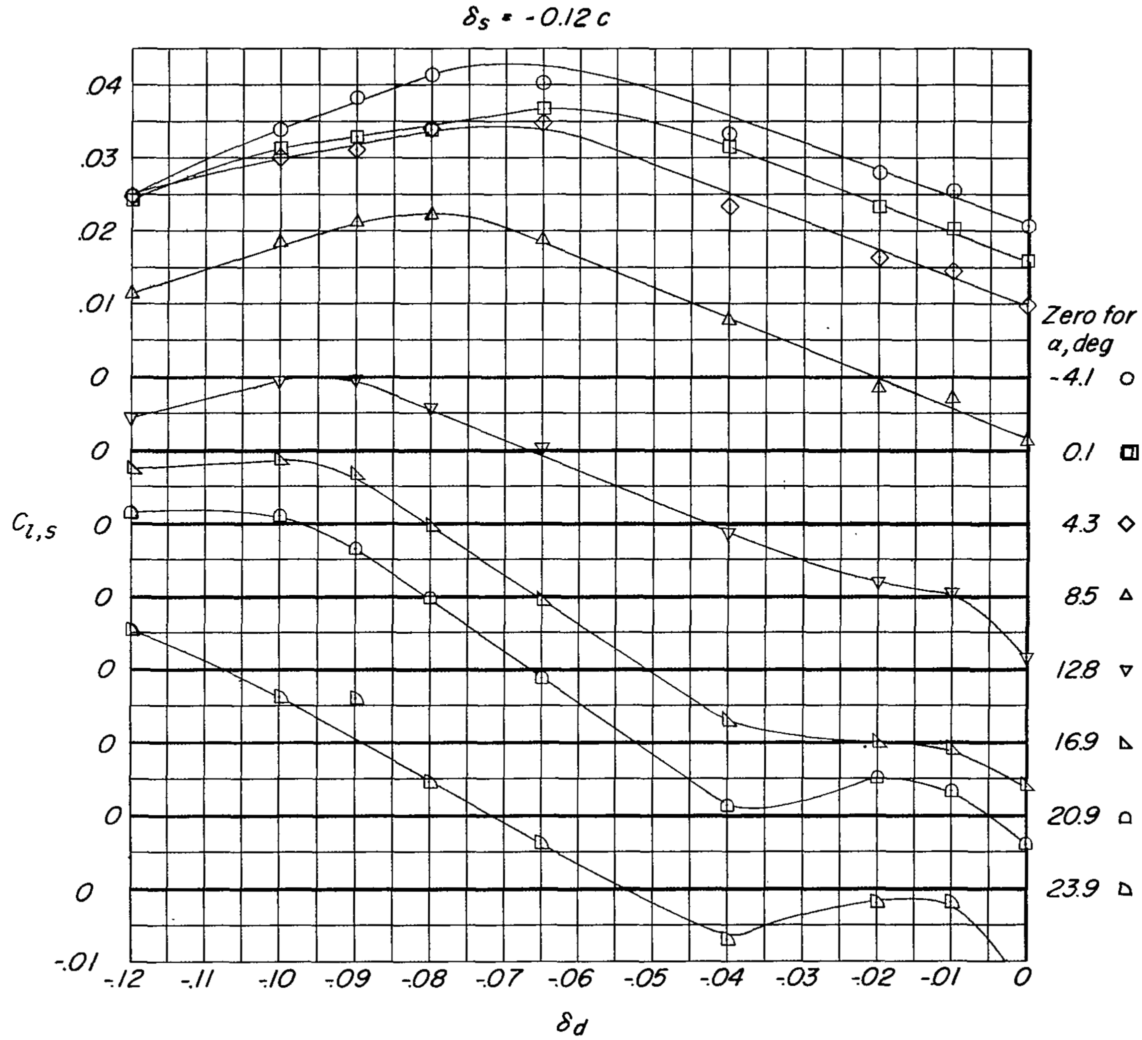

Figure 3.- Concluded.

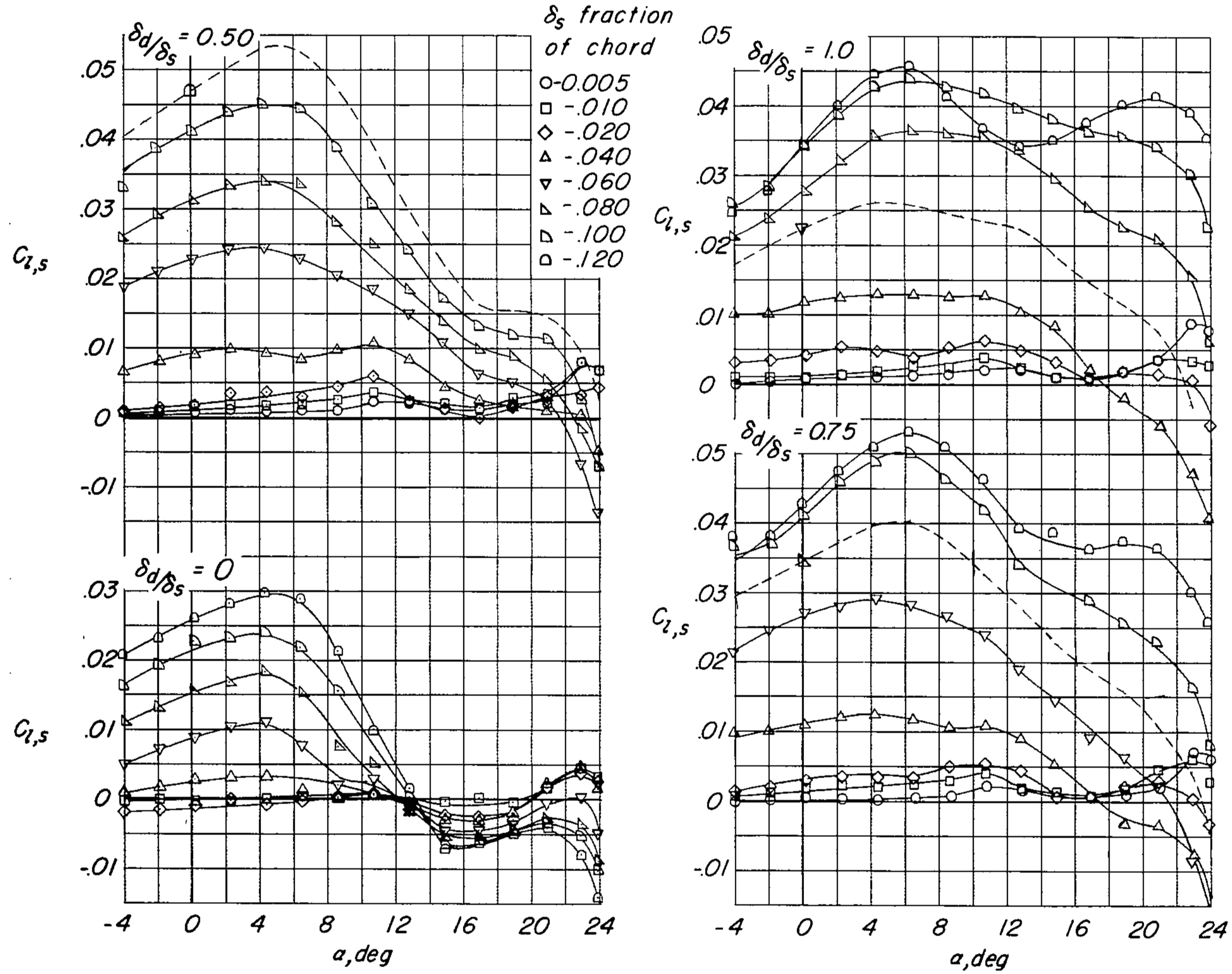

Figure 4.- Variation of the incremental rolling-moment coefficient with angle of attack for the plain spoiler and several spoiler-slot-deflector configurations at various control projections. Dashed lines indicate data taken from faired values of figure 3.

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